DOCUMENT RESUME

ED 436 391 SE 062 653

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TITLE Teaching Science Constructively: Examining Teacher's Issues When Teaching Science.
PUB DATE 1999-06-00
NOTE 16p.
PUB TYPE Opinion Papers (120)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Constructivism (Learning); Elementary Education; Higher Education; *Science Instruction; *Teacher Attitudes; Teaching Methods

ABSTRACT

This paper examines teachers' perceptions and attitudes concerning science as well as their methods of instruction. The paper reviews the literature concerning constructivism, which is the belief that people come to know the world through mental activity that organizes and transforms their perceptions. Constructivism is the notion that people build their own knowledge and their own representations of knowledge from their own experience. These perspectives are grounded in the cognitive and developmental perspectives of Piaget, the interactual and cultural emphases of Vygotsky, as well as the educational philosophy of John Dewey. The essay argues that teachers must allow students to learn for themselves that which the teacher already knows. Through a survey of teachers, the researcher found that most teachers view constructivist learning as the best method for teaching science. Most of these teachers believe that they are prevented from using this learning style by a combination of mandated district curriculums, inadequate or lack of equipment, and lack of experience and scheduled time. (Contains 11 references.) (CCM)

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Teaching Science Constructively:

Examining Teacher's Issues When Teaching Science

By Elizabeth Ramos

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Introduction

Constructivist perspectives on learning and teaching are increasingly influential today. These perspectives are grounded in the cognitive and developmental perspectives of Piaget, the interactual and cultural emphases of Vygotsky, as well as the educational philosophy of John Dewey. At the most basic level, constructivism is the belief that we come to know the world through mental activity that organizes and transforms our perceptions. It is the notion that people build their own knowledge and their own representations of knowledge from their own experience. Constructivist perspectives on learning have definite implications for teaching. Although there are several interpretations of what constructivist theory means, most agree that it involves a dramatic change in the focus of teaching, putting the students' own efforts to understand at the center of the educational enterprise (Prawat,1992, p.357).

Defining Constructivism

"Constructivism has multiple roots in the psychology and philosophy of this century" (Perkins,1991,p.20); Constructivism is a theory about how learning occurs. Constructivists view learning as a process not just of acquiring information, but of creating new understanding. Constructivists hold a unique set of philosophical beliefs that must be understood before one can grasp the concept.

Piaget's view of cognitive development is based on allowing children to build concepts actively rather than providing those concepts through direct teaching. This is the belief that each individual constructs knowledge and meaning for himself or herself.

Vygotsky's theory also suggests that in addition, a stimulating environment in which children are active explorers and participants should also be provided. Educators need to promote discovery by modeling, explaining, and providing suggestions to suit each child (Gallimore & Tharp,1990).

John Dewey's philosophies were based on the belief that learning is the result of experience and that the only way students learn is by tying new information to existing knowledge. He believed that teachers should teach students how to become problem-solvers by helping them learn how to think rather than simply learning rote lessons about large amounts of information.

Brooks (1990) explored the concept of constructivism and defined it as a process in which the individual is repeatedly verifying new information against old ones(p.68). Learning is a personal process requiring each individual to use newly acquired information to shape existing understanding, thus producing new insights. The use of constructivist theory also changes the role of the teacher. Constructivist teachers must use a personal approach, focusing attention on each student to make learning interesting to each student. A teacher's role, as defined by Brooks (1990), is one where two entities must occur simultaneously; the continued development of content knowledge

and the continued reconstruction of the method used to teach the knowledge(p.69). Therefore, a teacher must allow students to experience the concepts of the lesson through manipulation of materials or information. The teacher can subsequently present the new idea with new terminology, different thinking methodologies, as well as enhancing it by furthering activities using the same learned concepts. In essence, teachers must allow students to learn for themselves that which the teacher already knows.

Clearing Up The Myths

How teachers define constructivism has major implications in its implementations. Clements (1997) reflects on five myths that surround the practice of constructivism. 1) Students do not have to always be actively engaged to construct new knowledge. Manipulation can occur in the students' mind. 2) Students are not always actively learning when they use manipulatives. They may use the manipulatives in a futile attempt to reproduce the teacher's actions, thereby using manipulatives in a prescribed fashion. 3) The students do not lead themselves towards the conceptual ideas, teachers must guide them in that direction. 4) Teachers believe that if the students are working in groups or in Cooperative-Learning groups, that constructivism is taking place. 5) Teachers must still discriminate student's answers; not all answers are correct, they must make sense. Clements goes on further to say, that student can construct their learning from

lectures, if they are active listeners and think about the information at the same time, they are constructing their knowledge(p.199).

Constructivism On The Move

It is probably no accident that constructivism is gaining popularity and momentum at the same time that computer technology is becoming widely available. However, constructivism has taken a strong hold in many areas of education. Some of the most compelling support for this approach to teaching and learning comes from mathematics and most recently, science education.

Students often find science harder to learn than any other subject. In part, this is because science typically requires students to learn a great many new concepts very quickly. However, an additional problem is that students typically have develop misconceptions about the content they are or will be studying. Teachers present information directly to students and regard text as a repository of knowledge to be taught. "United States' textbooks lack focus and coherence and rarely provide teachers with effective instructional strategies to help students learn specific content (Nelson,1999,P.56). So, the instruction teachers provide not only fails to confront the students' misconceptions, but is also presented in such a general or imprecise way, that students can interpret the new input as consistent with their existing misconceptions (Anderson & Smith,1987).

Constructivism in Science

Yager (1991) disputes the arguments made by educators that seem to think that science can be taught by means of communication; teachers that are convinced that science is learned by rote vocabulary practices (p.55). Teachers need to realize that this form of transferring knowledge is not likely to lead to understanding and therefore learning cannot occur. Constructivist teachers try to avoid telling answers to their students and instead encourage them to develop their own ideas. Teachers aid learning by allowing situations to occur where students can discuss problem-solving ideas in groups with little or no interference from the teacher, as well as analyze their students' method of thinking and address the need where needed.

Common to all teaching approaches, appreciation and application of knowledge is the core idea of constructivism. Yager (1991) offers ten suggestions as a guide towards constructing a constructivist science classroom.

- allow students' interest and problems to direct the curriculum;
- have resources available as sources of information to allow for problem-resolution;
- allow the students to learn relevant life solving problem information;
- allow for learning to occur and extend out of the classroom as well as its allotted time;

- individualize the students' need for science;
- do not allow for science to become a learned roped activity solemnly done for the purpose of test performance;
- do not allow science to become a modeled process only to mimic the actions of scientists;
- allow for awareness in science or related science careers;
- allow the students the opportunities to deliver and resolve their issues;
- show that science and technology are interrelated in shaping the future.

Changing The Behavior

Educators must identify and understand the major concepts in the subjects being taught. They must find ways to lead their students to discover and develop those concepts. However, many educators utilize the textbooks as method for educating students the subject of science. Willis (1995) revealed that teachers are still relying on teaching from textbooks and lectures to transmit information to students. At the middle and high schools, ninety-five percent of the science classes use published textbook. Although the percentage is lower at the elementary level, still seventy-five percent of instruction is done via a textbook. The majority of class time is usually spent in lectures, specially at the middle and high school level (p.6). This has led to a

decrease in enrollment in high science education beyond what is required.

Standards as a Change

"While students may succeed in 'parroting back' phrases from lectures and text, they often falter when asked to apply their understandings to new situations (Gardner & Boix-Mansilla,1994,p.14). The National Science Education Standards will and have become guidelines that foster direction towards a more focused, less repetitive curriculum for all students. They provide excellent guidance for educators to improve the curriculum that is actually delivered to students (National Research Council,1996). They also describe what all students should know, understand, and be able to do as result of their learning experiences. " The standards specifies teaching, assessment, professional development, programs, system standards and perhaps, most important, it sets content standards that provide a set of ambitious learning goals for all students " (Locks-Horsley & Bybee,1998,p.22). They identify the most important ideas that scientifically literate students should know and be able to express. They include the development of student abilities to conduct inquiry as well as understanding. However, the standards must be implemented by more than just the classroom teacher. The standards must be incorporated within the school environment, which includes not only the entire school, but the district. Locks-Horsley and Bybee (1998) examine the changes that would be needed to be implemented within these environments as

well as describing what they would look like when implemented. If the standards are going to have a positive effects on students and their learning, all aspects of a students' education must be involved.

Just like the National English and Mathematics Standards were received, teachers must get acquainted with the standards as they apply to science. This means that the style in which some teachers present concepts may need modifications. Educators will need to include inquiry as a part of the outcome. Yet, some educators see no need to change from over using passive learner instructional methods, such as show and tell teaching. The basic problem becomes in convincing educators to implement different teaching techniques from their regemented methods. Leading the way in the reform of science, as it did for math, is the approach of constructivism. If educators are to aid students meet the new National Standards, changes in teaching must include such technique. Even though the math standards initiated the move towards constructivism, educators must be constantly convinced that such strategies work.

Examining Teacher's Beliefs

Reexamining the importance and validity of constructivist learning and theory in science education, which is currently considered as being the most outstanding contribution in this field over the last decade (Gruender & Tobin,1991), is not necessary. What does become necessary is understanding teacher's

perceptions and attitudes concerning science as well as their method of instruction.

By conducting a survey, I aimed to shed light on the issue's surrounding the teaching of science constructively. The responses were quantified and qualified when possible. The teachers were allowed to make additional comments to their responses in order to further explain their reasoning. The data revealed information from teacher's about their beliefs and practices towards constructivist teaching.

The Surveyed Group

* The grade levels represented in the survey consisted of third grade, fourth-grade, fifth-grade, sixth-grade, as well as science program teachers.
* The teacher's teaching experience ranged from 0 to 12 years, but averaged 10 years.

The Instruction of Science

* Many of the teachers reported using constructivist science instruction, but only 40 percent use it often.
* Although 68 percent believe that science is taught best using the constructivist approach, but many still rely primarily on textbooks for instruction.
* 43 percent never conduct in class science projects and many of the ones that do, count their yearly science fair projects.

* 60 percent of the teachers report that they never or almost never take field trips and the ones that do, do not make their trips science related.

Time for Science

* An average of only two hours per week is spent on science, even though 72 percent believe that science is as equally important as any other subject such as reading, writing or math.
* Nearly all teachers schedule science instruction in the afternoon. They expressed the need to assure time for reading and math, an assurance that can only be met by scheduling these subjects in the morning sessions. Many stated that this scheduling is mandated by their districts.
* The vast majority need to follow a district mandated curriculum, although only 32 percent follow it often.

The Need for Equipment

* 64 percent stated that resources and equipment are either lacking, insufficient, or non-functioning.
* The majority of their classrooms do not have the conveniences of sinks, running water, or let alone a reliable source of electrical power.
* Technical equipment, such as computers, are very rare in higher educational classroom.
* Most teachers believe that the students' current science

textbooks are outdated and that teacher's manuals are essentially are useless in aiding teachers to teach constructively.

Professional Development

* Although standards have been a widely discussed issue, only 52 percent of the teachers indicated to be familiar with the National Science Standards. About 56 percent have attended or received workshops to familiarize them with the standards.

Issues Concerning Constructivism

* Many teachers believe that the practice of constructivist teaching gets more difficult to implement as the students grow older. This is because 92 percent believe that the students engage themselves in discussions that are not relevant to the lesson.

* According to the teachers, as students get older they are least inclined to follow directions. 83 percent feel that this leads to deteriorating classroom management.

Conclusions

No doubt there will be those who will despute the many revelations in these findings. Most teachers who answered the survey view constructivist learning as the best method for teaching science. Most of these teachers believe that they are

prevented from using this learning style by a combination of mandated district curriculums, inadequate or lack of equipment, lack of experience and scheduled time. Many express the feelings of embracing such practices more frequently if they could overcome these obstacles.

Still, other teachers resist constructivist teaching. Their reasoning lies in concern for control. These teachers are more concerned with behavior and safety rather than student learning. This is more evident in the higher grades. The number of students increases in the higher grades, making classroom management more difficult when using learning techniques such as constructivism. Materials, tools and equipment would is also insufficient with larger classroom making provisions even more difficult.

Although the practice of constructivist teaching has proven to be effective in teaching science, these issues most be address if teachers are to help the students meet the the National Science Standards. Hopefully, as in the case with the National English and Mathematics Standards, there will be a surge of resources that would make this possible.

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